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Generative AI and the Metaverse: A Scoping Review of Ethical and Legal Challenges

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ABSTRACT The metaverse, a pioneering digital realm merging virtual and augmented realities with Artificial Intelligence (AI), represents a transformative environment where digital and physical realities converge seamlessly. Generative AI (GenAI) is indispensable in powering the metaverse's dynamic and immersive experiences, enabling the autonomous generation of diverse digital content. Large Language Models (LLMs), as a component of GenAI, play a critical role by facilitating real-time communication, multilingual translation, and personalized interactions, enhancing user engagement in shared virtual spaces. This scoping review explores the interdependence between GenAI and the metaverse and the unique ethical and legal challenges that emerge from their integration. It identifies key ethical and legal issues, such as bias in AI-generated content, misinformation, and data privacy concerns, related to the deployment of GenAI and LLMs, and offers strategic recommendations for addressing these challenges responsibly. Emphasizing the transformative potential of these technologies, this review highlights the necessity of developing tailored ethical and legal frameworks to manage their convergence responsibly, ensuring equitable and sustainable growth within the metaverse.

INDEX TERMS Ethics, extended reality, generative AI (GenAI), LLMs, metaverse, privacy, regulation, security.

I. INTRODUCTION

The metaverse represents a paradigm shift in digital interaction, offering a persistent, immersive media environment where physical and digital realities blend seamlessly. It is a complex and dynamic concept, continuously evolving and defying simple definition. Often described as a 3D extension of the current 2D internet, the metaverse is built on a foundation of Extended Reality (XR) technologies, including Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), combined with Artificial Intelligence (AI) [1]. As shown in Fig. 1, the progression from early virtual worlds to the modern metaverse represents a vast network of interconnected digital spaces. These immersive environments transcend the limitations of small screens and conventional interfaces, enabling users to engage in dynamic, shared experiences with a strong sense of presence. These spaces enable seamless navigation for activities such as socializing, working, learning, entertainment, shopping, and content creation. The metaverse supports ultrarealistic avatars, virtual conference rooms, virtual real estate, non-fungible tokens (NFTs), and decentralized autonomous organizations (DAOs) [7]. It is poised to develop its own economy, utilizing NFTs for ownership, smart contracts for transactions, and innovative digital identity governance for authentication [1]. Graylin and Rosenberg, in their book *Our Next Reality*, describe the metaverse as "the 3D version of the global internet we know, powered by AI and primarily accessed using XR devices" [2]. This underscores the indispensable role of AI technologies, including Generative AI (GenAI), in realizing the promise of the metaverse.

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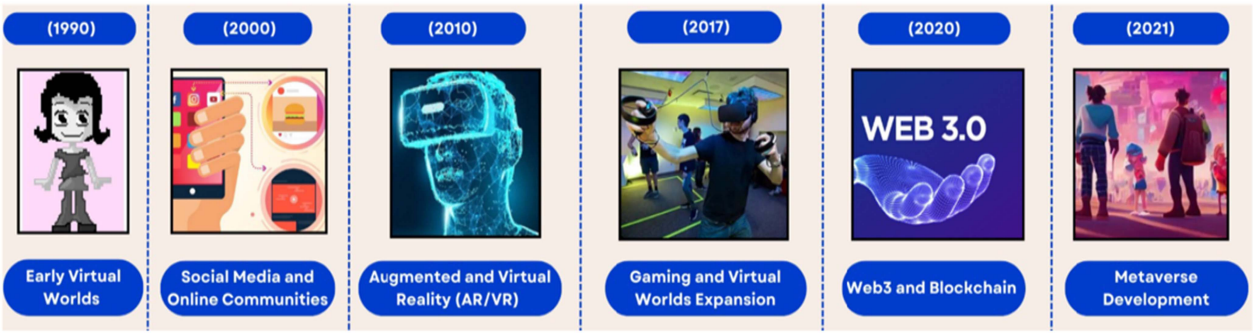

FIGURE 1. Development of the metaverse: Tracing the evolution from 1990's 3D environments to 2020's comprehensive virtual spaces, highlighting key advances in social media, AR/VR, gaming, and Web 3.0.

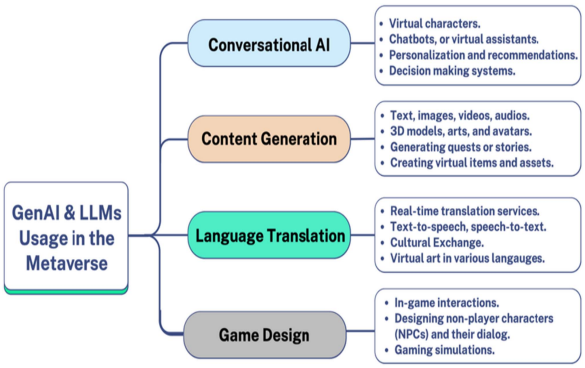
GenAI & LLMs Usage in the Metaverse
Conversational AI
• Virtual characters.
• Chatbots, or virtual assistants.
• Personalization and recommendations.
• Decision making systems.
Content Generation
• Text, images, videos, audios.
• 3D models, arts, and avatars.
• Generating quests or stories.
• Creating virtual items and assets.
Language Translation
• Real-time translation services.
• Text-to-speech, speech-to-text.
• Cultural Exchange.
• Virtual art in various langauges.
Game Design
• In-game interactions.
• Designing non-player characters (NPCs) and their dialog.
• Gaming simulations.

FIGURE 2. Overview of the diverse applications and roles of GenAI and language models in the metaverse.

A. GENERATIVE AI AND LLMS IN THE METAVERSE

GenAI, driven by techniques such as transformers, diffusion models, and generative adversarial networks (GANs), is a cornerstone for enabling the metaverse's vision. It autonomously generates diverse digital content—such as immersive virtual environments, personalized avatars, and interactive objects—that are essential for creating the metaverse's dynamic and adaptive experiences [8]. Large Language Models (LLMs), a key subset of GenAI, play a pivotal role in enhancing communication and interaction by providing real-time multilingual translation, natural language understanding, and personalized user engagement. These capabilities are critical for the metaverse's applications in social collaboration, education, and commerce, where users interact with intelligent entities and other participants in shared virtual spaces [37].

In the metaverse, GenAI and LLMs drive several key functions (see Fig. 2). Conversational AI powers virtual characters, chatbots, and virtual assistants, enhancing user engagement and supporting decision-making processes [8]. GenAI creates a wide range of content, including images, videos, and 3D models, enabling the development of virtual assets such as avatars and immersive environments, and designs dynamic non-player characters (NPCs) for gaming [4], [5]. LLMs provide real-time language translation, fostering inclusivity and cultural exchange.

By powering the creation of content, enabling seamless interaction, and driving personalization, GenAI addresses some of the metaverse's most significant technological challenges [10], [36]. The integration of GenAI into the metaverse is not arbitrary; it is essential for achieving the metaverse's transformative potential. However, this convergence also brings unique ethical and legal challenges, such as the potential perpetuation of cultural stereotypes, bias in AI-generated avatars, misinformation in immersive environments, concerns over data privacy and governance and issues of accountability [4].

Despite significant research on various aspects of GenAI and LLMs, there is a notable gap in studies focusing on the ethical and legal implications of these technologies, particularly in the context of the metaverse. Existing literature often addresses either the technical capabilities of GenAI and LLMs or the conceptual frameworks of the metaverse, but rarely do they explore the intersection of these technologies with ethical and legal considerations [20], [24], [27], [35], [48]. These gaps motivate our investigation, leading to the key research questions (RQs) that guide this review.

B. RESEARCH QUESTIONS (RQS) AND CONTRIBUTIONS

The specific RQs addressed in this paper are: RQ1. What are the ethical and legal concerns associated with the deployment of GenAI and LLMs for conversational AI and content generation within the metaverse?

RQ2. How does the use of LLMs and GenAI in the metaverse impact real-time language translation and gaming interactions, and what challenges arise from their implementation?

RQ3. How can ethical frameworks and legal principles be tailored to address the unique features and challenges presented by GenAI and LLMs in the metaverse?

Our previous work [5] explored the metaverse's technical aspects, origins, and potential societal and ethical challenges. Building on that foundation, this scoping review focuses on these unexplored challenges, providing actionable insights and strategic recommendations for ensuring that the integration of GenAI, particularly through LLMs, into the metaverse aligns with societal values, promotes responsible innovation,

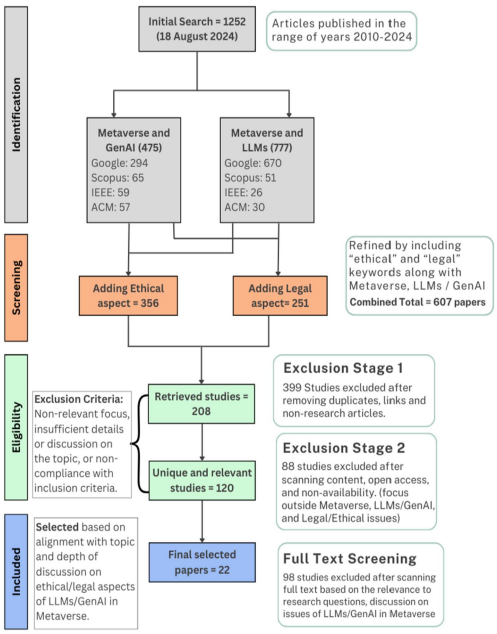
Identification
Screening
Eligibility
Included
Initial Search = 1252
(18 August 2024)
Articles published in the range of years 2010-2024
Metaverse and GenAI (475)
Google: 294
Scopus: 65
IEEE: 59
ACM: 57
Metaverse and LLMs (777)
Google: 670
Scopus: 51
IEEE: 26
ACM: 30
Refined by including "ethical" and "legal" keywords along with Metaverse, LLMs / GenAI
Combined Total = 607 papers
Adding Ethical aspect = 356
Adding Legal aspect= 251
Exclusion Stage 1
399 Studies excluded after removing duplicates, links and non-research articles.
Exclusion Criteria:
Non-relevant focus, insufficient details or discussion on the topic, or non-compliance with inclusion criteria.
Retrieved studies = 208
Exclusion Stage 2
88 studies excluded after scanning content, open access, and non-availability. (focus outside Metaverse, LLMs/GenAI, and Legal/Ethical issues)
Unique and relevant studies = 120
Selected based on alignment with topic and depth of discussion on ethical/legal aspects of LLMs/GenAI in Metaverse.
Final selected papers = 22
Full Text Screening
98 studies excluded after scanning full text based on the relevance to research questions, discussion on issues of LLMs/GenAI in Metaverse

FIGURE 3. The PRISMA chart illustrates the methodology by presenting a comprehensive overview of the entire study selection process.

and supports sustainable growth. This study synthesizes existing literature to identify key ethical and legal challenges in the integration of GenAI and LLMs in the metaverse. While empirical research is crucial to validate and refine these insights, the objective here is to provide a foundational understanding and roadmap for future empirical investigations.

To address these research questions, the paper proceeds as follows: Section II outlines the methodology followed in conducting this scoping review. In Section III, we examine the intersection of GenAI technology and the metaverse with ethical and legal values, such as transparency, equality, and accountability, addressing RQ1 and RQ2. Section IV outlines recommendations and strategies for the development and application of ethical and legal standards tailored for the metaverse, addressing RQ3. Finally, Section V presents our conclusions.

II. METHODOLOGY

We conducted a systematic scoping review following the guidelines of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Extension for Scoping Reviews (PRISMA-ScR) [15]. Our approach comprised six stages as depicted in Fig. 3.

Stage 1—Initial Search: We initiated a broad search for metaverse-related articles on popular databases including Association for Computing Machinery (ACM), Institute of Electrical and Electronics Engineers (IEEE), Scopus, and Google Scholar on 19 August 2024. We applied strategic keyword combinations related to the metaverse, Generative Artificial Intelligence (using variations such as GenAI, Generative AI), and Large Language Models. The number of articles retrieved has been illustrated in Table 1 indicating the cumulative count from individual databases for each keyword combination, with a total of 475 for Metaverse and GenAI, and 777 for Metaverse and LLMs. The overall count of articles retrieved during Stage 1, summing up to 1252 articles (see Fig. 3 - identification phase), providing a comprehensive foundation for subsequent stages of the scoping review.

TABLE 1. *Stage 1*: Number of Articles Retrieved With Independent Keyword Search on Each Database in the Beginning

Database	Metaverse and GenAI	Metaverse and LLMs
Google Scholar	294	670
Scopus	65	51
IEEE	59	26
ACM	57	30
Sub-Total	475	777
Total	**1252 (Identification Phase/Stage 1)**	

TABLE 2. Stage 2: Articles Retrieved With Keyword searches: Metaverse, GenAI/LLMs, and Ethics

Database	Metaverse, GenAI, and Ethics	Metaverse, LLMs, and Ethics
Google Scholar	87	203
Scopus	10	2
IEEE	4	9
ACM	26	15
Sub-Total	127	229
Total	**356 (Screening Phase/Stage 2)**	

TABLE 3. Stage 3: Articles Retrieved With Keyword searches: Metaverse, GenAI/LLMs, and Legal Issues

Database	Metaverse, GenAI, and Legal	Metaverse, LLMs, and Legal
Google Scholar	75	150
Scopus	1	2
IEEE	0	1
ACM	12	10
Sub-Total	88	163
Total	**251 (Screening Phase/Stage 3)**	

Stage 2—Refinement: Adding Ethics Aspect. Building upon the initial search, we refined our exploration by introducing the ethical dimension to our key word search queries. Notable articles were retrieved for "Metaverse, GenAI, and Ethics", and "Metaverse, LLMs, and Ethics", indicating representation of studies focusing on ethical considerations. The Sub-Total row represents the number of articles obtained from all databases for each keyword combination, 127 and 229, respectively. Total is the cumulative count showing 356 articles from both keyword combinations (see Table 2 and left part of Screening phase in Fig. 3)

Stage 3—Further Refinement: Adding Legal Aspect: In the subsequent stage we added the legal aspect with a keyword. The outcomes of this refined search are summarized in Table 3 (and right part of Screening phase in Fig. 3), revealing a total of 251 articles identified in this stage. We considered the cumulative results from both Stage 2 and Stage 3, making

TABLE 4. Stage 4: Articles Refinement Based on Relevancy on Metaverse, and Duplicity With Focus on "Metaverse, GenAI/LLMs, Ethics, and *Legal Issues*"

Database	Metaverse, GenAI, Ethics, Legal	Metaverse, LLMs, Ethics, Legal
Google Scholar	68	124
Scopus	0	5
IEEE	5	6
ACM	0	0
Sub-Total	73	135
Total	**208 (Eligibility Phase/Stage 4)**	

it 607, which ensures coverage of articles addressing ethical and legal aspects within the context of the metaverse, GenAI, and LLMs integration.

Stage 4 – Exclusion and Eligibility Check: From these 607 articles 399 studies were excluded to remove duplicates, non-research articles and irrelevant links (particularly from Google Scholar), resulting in a refined collection of 208 articles that explored this intersection. The outcome of this exclusion is detailed in Table 4.

Stage 5 - Analysis and Open Access Check: During this stage, we checked for open access availability, and analysed articles based on titles, abstracts and the availability of full texts. Our inclusion criteria specifically targeted studies that discuss ethical or legal issues arising from the implementation and usage of generative AI or large language models within the metaverse, leaving 120 unique and relevant studies for further analysis. Exclusion criteria was to eliminate articles with non-relevant focus, insufficient details or discussion on the topic, or non-compliance with inclusion criteria.

Stage 6 - Full-text screening: Concluding our rigorous methodology, the final step involved a full-text screening process to determine the relevance of the identified articles based on predetermined criteria. After thoroughly examining the full texts, abstracts, and conclusions, 98 studies were excluded from further consideration. These studies did not provide sufficient discussion on ethical or legal issues connected with LLM/GenAI within or without metaverse. They only offered an introduction to the topic or a brief overview without the in-depth discussion necessary to identify specific challenges. In culmination, our systematic literature review yielded the identification of 22 articles that specifically addressed the metaverse, GenAI, Large Language Models, as well as ethical and legal considerations.

The articles included in our study are shown in Table 5 showcasing what aspects are discussed in those papers. This table provides a curated list of works focusing on LLMs, GenAI, and the metaverse, particularly emphasizing ethical and legal challenges. Each entry includes the reference, publication year, indication of whether the work addresses LLMs, GenAI, and the metaverse, and specifies if ethical and legal aspects are covered, "√" indicates the inclusion of the respective element, while "x" indicates its absence. While the Table 6, highlights the significant insights offered by the selected research articles in addressing the research questions (RQs) of the study.

III. RESULTS: ETHICAL AND LEGAL ISSUES OF GENAI AND LLMS IN THE METAVERSE

In this paper, we have identified four key domains for investigation: (1) conversational AI, (2) content generation, (3) real-time language translation, and (4) gaming interactions and NPC dialogue. These domains were established as a priori criteria in our Research Questions (RQs) because they represent the core applications of GenAI and LLMs within the metaverse. By examining these concerns across key domains, we aim to highlight the potential risks and propose strategies for mitigating them, thereby fostering a more responsible and sustainable metaverse.

In the following subsections, we discuss several ethical and legal challenges that arise in these domains within the metaverse. We acknowledge the potential overlap between ethical and legal aspects; however, our categorization of each issue as either ethical or legal emphasizes the primary focus based on the authors' combined judgment.

A. RQ1: ETHICAL AND LEGAL COMPLEXITIES IN CONVERSATIONAL AI SYSTEMS

Virtual Personal Assistants (VPAs) in the metaverse respond to user queries and analyze behavior to offer personalized recommendations for products, movies, music, and more [12]. VPAs like Siri, Google Assistant, and Amazon Alexa leverage conversational AI, continuously learning from interactions. This raises ethical concerns about user *autonomy*, defined as the ability to make self-directed choices free from external influence. VPAs, relying on GenAI and LLMs with minimal human intervention, can subtly undermine users' freedom of choice, nudging them towards specific decisions [39]. Continuous exposure to AI-driven suggestions fosters dependency and erode independent decision-making, especially given the immersive nature of the metaverse.

Another ethical concern is *discrimination* perpetuated by these AI systems. VPAs base recommendations on user data, which can lead to discriminatory outcomes due to *biases* in training datasets [41], [49]. Discrimination manifests as exclusion or preferential treatment based on race, gender, socioeconomic status, or other characteristics. For example, VPAs might inadvertently recommend job opportunities or healthcare options in a discriminatory manner, perpetuating societal inequalities and violating principles of *fairness* and *equity* within AI systems [30].

Similarly, virtual influencers and AI chatbots use vast amounts of data to generate contextually relevant responses [8]. These applications often reinforce users' beliefs and preferences, creating 'information bubbles' that lead to echo chambers [45]. This can diminish critical thinking skills, reduce exposure to diverse viewpoints, and exacerbate societal polarization [48]. Moreover, frequent interaction with virtual entities foster addiction and emotional dependency, negatively

TABLE 5. List of Existing Works That Concentrate on LLMs, GenAI and the Metaverse, With a Specific Emphasis on Ethical and Legal Challenges

Reference	Year	LLMs	GenAI	Metaverse	Ethical Issues	Legal Issues
Ungureanu et al [3]	2023	x	✓	x	x	✓
Mohamadi et al. [8]	2023	x	✓	x	✓	x
Nripendra et al. [9]	2024	x	✓	x	✓	✓
Vera Liao et al. [17]	2023	✓	x	x	✓	x
Wang [18]	2023	✓	x	x	✓	x
Ferrara [20]	2024	✓	✓	x	✓	✓
Ray [23]	2023	✓	x	x	✓	✓
Dwivedi et al. [24]	2023	x	x	✓	✓	✓
Dwivedi et al. [25]	2023	✓	✓	x	✓	✓
Fui-Hoon et al. [26]	2023	x	✓	x	✓	✓
Abbott et al. [27]	2023	x	✓	x	x	✓
Treleaven et al. [30]	2023	x	✓	x	✓	✓
Le Cheng et al. [31]	2023	x	✓	x	✓	✓
Lucaj et al. [33]	2023	x	✓	x	x	✓
Alesia [34]	2024	x	x	✓	✓	✓
Isaac et al. [37]	2024	✓	✓	x	✓	x
Kirk et al. [45]	2023	✓	x	x	x	✓
Laakso [46]	2023	✓	✓	x	✓	✓
Wu et al. [48]	2023	x	✓	✓	✓	x
Kumar et al. [49]	2023	✓	✓	x	✓	✓
Mihai et al. [50]	2024	x	✓	x	✓	x
Michał [51]	2021	x	✓	x	✓	✓

TABLE 6. Key Contributions of Research Articles Selected for Scoping Review

Reference	Key Contribution	Related RQs
[3]	Analyzes legal issues raised by GenAI across different jurisdictions, with a focus on liability and data usage.	RQ1, RQ3
[8]	Addresses critical concerns of ethical implementation of ChatGPT, including regulatory and public response issues.	RQ1
[9]	Offers actionable insights for integrating ethical values into GenAI systems and impacts.	RQ3
[17]	A human-centered approach to transparency in AI, identifying challenges and outlining future research directions.	RQ1
[18]	Reviews interpretability issues and discusses practical solutions for improving LLM transparency.	RQ1, RQ3
[20]	Summarizes existing research on ChatGPT/LLMs and provides a roadmap for future research.	RQ1, RQ2
[23]	Reviews ChatGPT's applications, challenges, biases, and future developments.	RQ1
[24]	Proposes a comprehensive framework for understanding the metaverse's technological, legal, and societal impacts.	RQ1, RQ2
[25]	Identifies key research questions and provides a balanced view of ChatGPT's benefits and challenges.	RQ2
[26]	Provides a holistic view of ethical challenges surrounding generative AI.	RQ1
[27]	Proposes that AI-generated works should be eligible for copyright protection.	RQ3
[30]	Explores the transition from human-centric crimes to algorithm-driven and decentralized cybercrimes.	RQ1
[31]	Analyzes thematic intertextuality between AI ethical and legal discourses.	RQ1
[33]	Provides concrete recommendations for operationalizing AI regulations.	RQ3
[34]	Highlights ethical challenges in AI integration within the Metaverse and proposes strategies for responsible AI implementation and governance.	RQ2, RQ3
[37]	Discusses societal implications, governance needs, and technical challenges of generative AI.	RQ1, RQ3
[45]	Proposes a three-tiered policy framework for managing personalized LLMs.	RQ2
[46]	Reviews ethical issues related to LLMs and links them to established AI ethics guidelines.	RQ2
[48]	Examines the integration of AIGC with the Metaverse and its potential impacts.	RQ2
[49]	Discusses key ethical concerns such as bias, privacy, transparency, and accountability in LLMs.	RQ1
[50]	Summarizes on aligning GenAI policy and technology, identifying gaps of regulatory needs and technical.	RQ3
[51]	Proposes new governance models and ethical guidelines for AI development, focusing on human rights and privacy.	RQ3

We have shown how these articles give insights to the RQs and helps in answering them.

impacting individual, collective well-being, and the quality of human relationships [11].

Ferrer et al. [12] examined the potential of GenAI and LLMs within online dispute resolution, scrutinizing their effective integration, necessary technological prerequisites, and inherent challenges and constraints. However, GenAI and LLMs often operate as "black boxes," making it challenging to understand how they arrive at specific decisions or recommendations [13]. The complexity of AI systems, particularly those employed within the metaverse, often results in a lack of *transparency* in decision-making processes. This opacity is not merely a by-product of complex algorithms but a fundamental challenge impacting the ethical deployment of AI technologies in general [17]. Challenges emerge due to the intricate legal liability issues when individuals rely on advice from GenAI and LLMs in the metaverse. Without transparency, these systems risk becoming unaccountable and untrustworthy entities within the metaverse [23], [49].

GenAI and LLMs, despite their efficiency and analytical capabilities, often struggle to contextualize cases, adapt to evolving legal norms, and mitigate biases inherent in their training data, raising significant ethical and legal concerns [41]. The challenges posed by conversational AI in the metaverse underscore the delicate balance between leveraging AI's capabilities and maintaining ethical standards. As these systems become more embedded in virtual environments, addressing issues such as autonomy, fairness, and transparency will be crucial to ensuring that the metaverse evolves as a space that upholds human rights and fosters equitable interactions [13], [46], [51]. These ethical considerations are not isolated but deeply interconnected with the broader implications of AI-driven content generation, which we will explore in the following section.

B. RQ1: ETHICAL AND LEGAL CHALLENGES RELATED TO CONTENT GENERATION

GenAI and LLMs offer significant advantages for content creation, creative writing, and educational purposes. However, they also pose risks, such as spreading misinformation and disinformation, which can erode user trust and have real-world effects [20]. In the metaverse, AI-generated content's impact is significantly amplified because it can be created and distributed on an unprecedented scale and speed. This capability increases the risk of *misinformation*—incorrect information—and *disinformation*—deliberately misleading content—spreading rapidly and transcending virtual boundaries, potentially causing real-world harm to individuals and communities [20], [26]. Additionally, LLMs can generate convincing yet incorrect content referred as *hallucination*, exacerbating biases and affecting sectors like journalism and education [28]. Moreover, deepfakes, or hyper-realistic AI-generated content, further complicate matters by blurring the line between reality and fabrication [52]. This can infringe on rights, such as unauthorized use of personal likenesses, and pose ethical challenges to *authenticity* and *trust*. The legal framework for addressing deepfakes is complex, involving

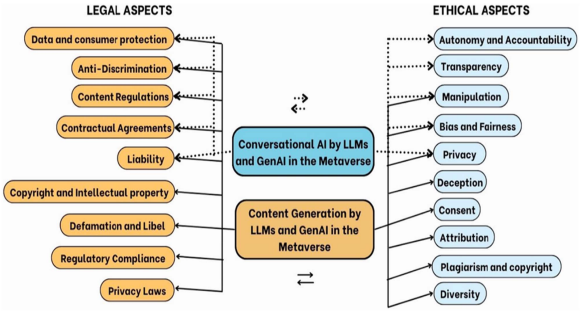

FIGURE 4. Ethical and legal issues in the metaverse related to GenAI and LLMs for conversational AI (CAI – dotted lines) and content generation (CG – solid lines).

issues related to cybersecurity, defamation, and intellectual property.

Capabilities of GenAI and LLMs in the metaverse also raise questions concerning *Intellectual Property Rights (IPRs)*, particularly regarding the use and ownership of copyrighted materials for training and the determination of ownership for AI-generated content [3], [27]. Determining ownership rights for virtual assets, such as digital real estate and in-game items, also necessitates legal frameworks to address disputes and transactions. Additionally, *privacy* concerns are prominent due to the metaverse's immersive nature, which complicates obtaining and managing user consent [6], [21]. XR equipment's extensive data collection—tracking motion, posture, gaze, and environmental responses—introduces challenges not yet fully addressed by current legal and ethical frameworks [16].

The ethical and legal challenges surrounding AI-generated content in the metaverse highlight the need for robust frameworks to manage the potential for misinformation, intellectual property disputes, and privacy violations [3], [39], which we will elaborate in RQ3 discussion in Section V. As content generation is intrinsically linked to user experience and engagement, these issues will significantly shape the development of virtual spaces. We summarize ethical and legal issues that emerge from these findings, related to RQ1 in Fig. 4.

C. RQ2: ETHICAL AND LEGAL ISSUES RELATED TO REAL-TIME LANGUAGE TRANSLATIONS

In the metaverse, language translations using LLMs face challenges such as *biases* and inaccuracies, particularly with nuanced or idiomatic expressions [46]. These errors can lead to misunderstandings, disrupt meaning, and threaten linguistic diversity [22]. Mistranslations, especially during humanitarian crises, can impede relief efforts and exacerbate issues for affected communities. Biased translations can reinforce stereotypes and *cultural insensitivity*, leading to discriminatory outcomes and limiting access for underrepresented groups [4], [43], [47]. As AI becomes more integrated into decision-making, content generation and language translations, addressing *liability* and *accountability* for these biases remains complex [46], [49]. These challenges highlight the

need for addressing ethical concerns and improving *fairness* in translation processes, directly relating to RQ2 and RQ3.

Simultaneously, users lack sufficient control over the translation process and be unaware of how their data is used. This *lack of agency* can lead to unauthorized access and misuse of personal information. Ensuring *privacy* and *security* during translations is crucial to prevent such breaches [36], [51]. Developers must ensure that translation processes comply with data protection regulations and user consent rights [28]. Additionally, handling copyrighted texts requires strict adherence to intellectual property laws to avoid legal issues related to unauthorized translations.

The complexities of real-time language translation in the metaverse reveal critical vulnerabilities in AI-driven communication. These challenges not only threaten the accuracy and fairness of translations but also raise broader concerns about cultural representation and privacy within these virtual spaces. The potential impact on user trust and the preservation of linguistic diversity further underscores the necessity for robust governance, which is similarly crucial in the realm of gaming interactions and NPC dialogue.

D. RQ2 - CHALLENGES RELATED TO GAMING INTERACTIONS AND NPC DIALOGUE

GenAI and LLMs showcase remarkable proficiency in crafting coherent dialogues and generating diverse content for the dynamic realm of the metaverse. This extends to the creation of intelligent Non-Player Characters (NPCs), automated Question-Answer systems, story-telling, and intricate dialogue systems [42]. In the context of virtual environments driven by LLMs, NPCs evolve into intelligent entities, dynamically adapting to user interactions to heighten overall immersion.

GenAI and LLMs can inadvertently produce inappropriate or offensive content in NPC dialogues, leading to negative user experiences and potential harm. This necessitates measures to protect player well-being and mitigate liability concerns [36]. Additionally, the potential for NPCs to manipulate player behavior raises ethical questions about player *autonomy* and decision-making [24]. Developers must ensure that NPC interactions are designed to avoid manipulative practices and defamatory content to maintain a fair and transparent gaming environment [42].

The integration of GenAI and LLMs in NPC dialogue also raises issues related to player rights, including compliance with intellectual property laws, data ownership, and consent [30], [21], [9]. Developers must ensure that NPC dialogue does not infringe on copyrights or trademarks and adhere to consumer protection laws [48]. Biased NPC behavior can unfairly impact players, highlighting the need for inclusive design. Additionally, robust cybersecurity measures are essential to protect player data and address potential legal liabilities from security breaches.

GenAI-driven NPC interactions can create highly engaging and potentially addictive gameplay experiences [24].

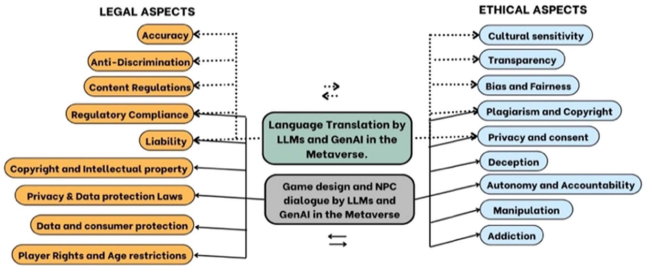

FIGURE 5. Ethical and legal challenges posed by LLMs and GenAI in language translation (dotted lines), and game design, and NPC dialogue (solid lines).

While enhancing immersion, this can lead to excessive playtime, affecting player health and well-being. The potential for *addiction* poses both physical and psychological risks, contributing to potential health problems and mental health issues. For some users, the metaverse serves as an escape from reality, potentially exacerbating mental health issues and challenges [11]. While *escapism* can offer temporary relief, it contributes to difficulties in addressing real-world responsibilities and mental health concerns. Developers must balance engagement to prevent addiction and align game content with appropriate age ratings. This is crucial for ensuring player safety and addressing mental health concerns associated with immersive gaming experiences. We summarize the ethical and legal issues that emerge from these findings related to RQ2 in Fig. 5.

Recognizing these challenges underscores the urgent need for effective regulation and mitigation strategies, which will be discussed in the following section, addressing RQ3. It is crucial to incorporate moral guidelines into GenAI and LLMs to ensure that safety, reliability, and ethical considerations are upheld in these virtual environments [18].

IV. RQ3: STRATEGIES TO MITIGATE THE IDENTIFIED RISKS OF GENAI AND LLMS IN THE METAVERSE

This section outlines a multi-pronged strategy for risk mitigation that includes establishing ethical AI practices, defining content ownership, enhancing privacy and consumer protection, ensuring accountability, and promoting equitable access. We will also discuss safeguarding against the misperception of AI intentionality, maintaining transparency in data usage, and enforcing rigorous algorithm auditing and moderation [33]. This comprehensive approach aims to ensure the responsible development and integration of AI technologies within the metaverse.

A. ETHICAL AI DEVELOPMENT IN THE METAVERSE

The Brookings Institution's AI and Emerging Technology (AIET) Initiative highlights the necessity for enhanced fairness, transparency, and privacy within AI algorithms across various sectors [55]. This includes addressing algorithmic bias, such as unequal medical treatments and gender-based discrimination, by enforcing behavioural standards for

algorithms to prevent bias and misbehaviour, while also adopting differential privacy measures to safeguard sensitive data more effectively than traditional anonymization techniques [32], [51].

To ensure ethical AI development in the metaverse, it is crucial to establish universal ethical guidelines aligned with societal values and responsible practices [5]. Proactive regulatory measures must oversee technology companies, ensuring compliance with ethical standards and intellectual property rights [29]. Companies like Telefonica provide models for ethical AI deployment, emphasizing human rights and inclusiveness [19]. Additionally, frameworks such as UNESCO's recommendations should guide principles of fairness, privacy, security, and the protection of vulnerable groups to maintain an ethically responsible metaverse [35].

The opacity and lack of interpretability in GenAI and LLMs present significant challenges. This lack of transparency can obscure model failures, leading to overestimation of capabilities and complicating the assessment of inappropriate use cases by developers and regulators [18]. Explainability is crucial for "Meaningful Human Control" and for ensuring that AI systems operate fairly and ethically [14]. Scholars stress the need for AI systems to provide understandable and interpretable rationales for their decisions, integrating transparency with explainability [26], [17]. Technically, this involves breaking down complex models into comprehensible parts, though this is challenging due to the non-linear nature of AI algorithms [18], [9]. Legally, explainability is essential for accountability and compliance with standards that demand fairness and non-discrimination.

Auditing further supports explainability by systematically evaluating AI systems against ethical, legal, and operational standards [33]. While explainability fosters understanding and trust, auditing identifies and mitigates biases, errors, and overreach. Both robust auditing practices and enhanced explainability are necessary to ensure AI systems are transparent, accountable, and fair [47].

B. REGULATORY OVERSIGHT IN THE METAVERSE

In the rapidly evolving landscape of the metaverse, the development of Ethical AI is crucial, demanding a multifaceted approach that encompasses technical, regulatory, political, and economic dimensions [25], [50]. Ensuring that AI and metaverse engineers are thoroughly trained in ethics is vital, as highlighted by Goldsmith and Burton [38]. This training goes beyond mere compliance with ethical norms; it cultivates a mindset where ethical considerations are deeply ingrained in the design and deployment of AI technologies. This is further complemented by the principle of ethics by design when developing AI systems as advocated by the European Commission [27]. Lucaj et al. stress the insufficiency of regulation alone in fostering responsible AI development, advocating for a holistic strategy that combines education, policy-making, and economic incentives [33]. Furthermore, Erdélyi and Goldsmith emphasize the necessity of global regulatory solutions to manage the complexities of AI, underscoring the need for international standards and guidelines [28], [34]. This comprehensive and integrated approach is essential to ensure that the AI ecosystem within the metaverse is not only technologically sophisticated but also ethically responsible and socially beneficial [50].

Additionally, the rise of LLMs in content creation introduces intricate issues concerning authorship, plagiarism, ownership, and intellectual property rights in the digital realm. IPR typically grant creators exclusive rights over their inventions and creations, including patents, trademarks, and copyrights [27]. In the metaverse and with technologies like NFTs, where digital assets are highly valued, establishing clear ownership is crucial [7]. While specific laws for these emerging technologies are still evolving, existing copyright, trademark, and patent laws offer a starting point for managing these issues. Copyright needs to be extended to LLM-generated content that meets originality criteria, while trademark laws needs updating to fit virtual environments. Innovative content must be protected under patent laws. Contractual agreements among content creators, platform operators, and users are essential for defining rights and responsibilities concerning AI-generated content [53]. Furthermore, robust Digital Rights Management (DRM) technologies must be regulated to ensure effective control over access and usage of digital content, thereby reinforcing intellectual property management in the digital space [32].

C. INTEGRATION OF PRIVACY AND CONSENT GUIDELINES

Moreover, in the metaverse, where GenAI and LLMs handle vast amounts of personal data, stringent adherence to data protection laws like the General Data Protection Regulation (GDPR) and California Consumer Privacy Act (CCPA) is essential [16], [56]. These regulations mandate transparent practices for data collection, processing, and storage. The metaverse's immersive nature necessitates stringent data privacy protections, which can be achieved through GDPR's principles of data protection by design and default. Platforms must ensure that XR devices and AI systems are designed to minimize data collection and processing, with explicit user consent obtained for all data uses [56]. The 2024 European Union (EU) AI Act classifies the use of biometric data as a high-risk AI application due to its sensitivity and potential for misuse [6], [55]. The EU AI Act further reinforces these protections by requiring AI systems that process personal data to undergo rigorous risk assessments and implement robust security measures. This classification mandates strict compliance measures, including human oversight and rigorous risk assessments, to safeguard individual rights and uphold public trust [5]. Furthermore, the Act's high-risk classification for AI applications should incorporate provisions for monitoring and mitigating the spread of deepfakes and misinformation within immersive environments [55]. Nevertheless, emerging digital identity systems, such as the European Digital Identity Wallet

TABLE 7. Strategies for Mitigating Risks of GenAI and LLMs in the Metaverse

Strategy	Category	Recommendation	References
Ethical AI Development	Ethical Guidelines and Standards	Establish universal ethical guidelines aligned with societal values to ensure responsible AI development in the metaverse.	[55], [11], UNESCO [35], [37], [9]
Algorithm Explainability	Explainability and Transparency	Implement mechanisms for AI systems to provide understandable rationales for their decisions, integrating transparency with explainability.	[12], [14], [17], [18], [26], [34], [37], [50], [9], [11]
Regulatory Oversight	Ethical AI by Design and Regulatory Compliance	Ensure AI development includes ethics by design, with thorough regulatory compliance to meet global standards and guidelines.	European Commission [27], Erdélyi & Goldsmith [28], Lucaj et al. [33], [19]
AI-Generated Content	Intellectual Property and Ownership	Define clear ownership and intellectual property rights for AI-generated content, with updated laws and contractual agreements in the digital realm.	[6], [7], [11], [27], [32], [54], [34]
Privacy and Consumer Protection	Data Protection and Privacy Regulations	Adhere to data protection laws like GDPR and CCPA, with enhanced privacy techniques to safeguard sensitive information in the metaverse.	GDPR [16], EU AI Act 2024 [5] [6], [11], [29], [51], [56], [57]
Accountability and Liability	Accountability Standards and Liability Framework	Establish clear legal frameworks to define responsibility for AI-drive decisions, ensuring fairness, non-discrimination, and alignment with ethical standards.	[5], [11], [22], [28], [36], [46]
Equitable Access and Inclusion	Bias Mitigation and Inclusive Design	Embed fairness and justice into AI algorithms, with regular audits and representative datasets to prevent discrimination and ensure inclusivity.	Afnan et al. [40], [55], [23], [46], [11]

(EUDI), present potential solutions for mitigating misinformation and deepfakes but raise privacy concerns [20]. The risk of LLMs leaking sensitive information underscores the need for sanitized training datasets and enhanced privacy techniques, such as differential privacy, anonymization and secure storage [29], [43]. The metaverse must also address real-world issues like cyberbullying, harassment, and data breaches. Vulnerable groups, such as Muslim American women facing discrimination, highlight the need for protecting users from inappropriate behaviour and data exposure [44].

Besides, traditional consent models, which often involve lengthy and complex terms, fall short in the metaverse's immersive environment. Users should be able to easily understand and control how their data is used [31]. Self-sovereign identity management addresses these issues by allowing users to manage their data and identities in a decentralized manner, thereby improving user agency and consent clarity, directly relating to RQ3 on ensuring accountability and ethical data use [20].

D. ENSURING EQUITABLE REPRESENTATION AND ACCESS

The algorithms of GenAI and LLMs can inadvertently perpetuate biases present in their training data, which can lead to discriminatory practices, particularly in sensitive areas such as online job recruitment [25]. Biases based on gender, ethnicity, or religion can skew opportunities, as highlighted by studies such as those by Afnan et al. [40]. To address these issues, it is crucial to embed fairness and justice into the algorithms of GenAI and LLMs within the metaverse.

Regular audits and the use of diverse, representative datasets are essential for identifying and mitigating biases. Proactive measures, including careful data curation and the refinement of LLMs, are necessary to prevent the generation of harmful language and ensure safety in deployment [23]. Filters to screen out discriminatory or harmful content should be implemented to protect underrepresented groups and uphold ethical standards [55].

Likewise, addressing accountability and liability for GenAI and LLMs in the metaverse involves two primary challenges: ensuring that these systems are inherently fair and unbiased, and establishing clear legal frameworks that define responsibility for AI-driven decisions [46]. This responsibility spans from the developers of AI systems to the entities deploying these technologies within the metaverse. A comprehensive accountability approach ensures that all parties in the AI lifecycle—development and deployment—are responsible for the outcomes, aligning with RQ1 and RQ3 regarding ethical and legal standards [22], [28], [37]. Additionally, the legal implications of AI-driven avatars in the metaverse introduce further complexities. Issues like representation, liability, and the actions of avatars, which operates semi-autonomously or obscure real-world identities, highlight the necessity for nuanced legal approaches [36], [37]. The European Union's AI Act, as the first legal framework addressing Generative AI risks, will be pivotal in developing these approaches [5].

Addressing the ethical and legal challenges posed by GenAI and LLMs in the metaverse requires a nuanced understanding of stakeholder dynamics. Developers and platform operators often prioritize innovation and user engagement, while regulators focus on public safety and ethical compliance [27]. Users, on the other hand, value privacy, transparency, and equitable access. Conflicts may arise when these priorities diverge, necessitating collaborative frameworks to align interests. For example, multistakeholder governance models, as demonstrated in the European Union's AI Act consultations,

can provide a blueprint for inclusive decision-making [5]. Regular stakeholder dialogues, coupled with accountability mechanisms such as independent audits and ombudsperson roles, can mitigate conflicts while fostering trust. These frameworks must also address power asymmetries, ensuring that underrepresented groups have a voice in shaping ethical and legal standards for the metaverse.

Table 7 provides a structured summary of proposed strategies for mitigating the ethical and legal risks of GenAI and LLMs in the metaverse. While these strategies address key challenges such as regulatory oversight, algorithm transparency, and equitable access, their feasibility and effectiveness require validation through empirical research. For instance, implementing regulatory measures like GDPR and the EU AI Act in regions with varying legal frameworks necessitates localized adaptations. Similarly, mechanisms for algorithm explainability need to account for the technical and resource constraints of smaller platforms [56]. This scoping review identifies these gaps and emphasizes the need for future research to evaluate the operational impact and refine these strategies in specific contexts. By doing so, it provides a conceptual roadmap for advancing the responsible and equitable development of AI technologies in the metaverse.

V. CONCLUSION

The metaverse represents a transformative evolution of the Internet, encompassing a rich array of interconnected digital spaces where individuals interact and engage through various modalities, including immersive 3D environments, augmented reality, and mixed-reality experiences. Beyond mere 3D immersion, the metaverse reflects advancements in user interfaces, programming, connectivity, and Internet economics.

This paper aims to contribute to the foundational development of the metaverse, rather than merely observing its evolution. Given that the metaverse is in its nascent stages, there is a significant opportunity to shape its trajectory proactively. Understanding and addressing the potential consequences from the outset is essential for guiding its development in a manner that aligns with societal values and ethical standards. It is crucial for companies to anticipate and mitigate societal and ethical risks associated with their metaverse endeavours. Recommendations from international stakeholders can help navigate these challenges, drawing from existing experiences with AI governance. While some aspects of metaverse technology eventually fall under legal regulation, it is imperative that such regulation be informed by interdisciplinary and global discussions to avoid premature or misaligned measures. The conclusions of this scoping review are based on a comprehensive synthesis of existing literature, and the proposed strategies draw from documented best practices. However, empirical verification remains an important next step to test the applicability of these strategies in specific contexts, which we recommend as a priority for future research.

APPENDIX

TABLE 8. List of Acronyms

Acronym	Full Form
AI	Artificial Intelligence
AR	Augmented Reality
AIGC	AI-Generated Content
CCPA	California Consumer Privacy Act
DAOs	Decentralized Autonomous Organizations
DRM	Digital Rights Management
EU	European Union
EUDI	European Digital Identity Wallet
GDPR	General Data Protection Regulation
GANs	Generative Adversarial Networks
GenAI	Generative Artificial Intelligence
IPR	Intellectual Property Rights
LLMs	Large Language Models
MR	Mixed Reality
NFTs	Non-Fungible Tokens
NPCs	Non-Player Characters
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RQ	Research Question
UNESCO	United Nations Educational, Scientific and Cultural Organization
VPAs	Virtual Personal Assistants
VR	Virtual Reality
XR	Extended Reality

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